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MAIN TOPIC

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Vesical exstrophy: repair using radical mobilisation of soft tissues

Abstract By more radical mobilisation of both internal and external sphincter muscles of the bladder und urethra than has hitherto been undertaken, physiological continence of urine has been achieved in patients with vesicourethral exstrophy. The purpose of this paper is to describe the surgical technique used in the type regarded as the classic anomaly, though the principles apply to all variants in males and females. The key features are relevant to the second stage of a three-stage procedure. The periosteum on the inner sides of the ischium and pubis with the attachments of the involuntary and voluntary sphincter muscles and the pudendal vessels and nerves is mobilised on both sides so that these outstretched muscles can be converted into a wrap around the newly constructed "membranous" urethra without the need for iliac or pubic osteostomy. This new "membranous" urethra is made from the urethral plate, which is uplifted from its bed on the dorsum of the penis, rotated posteriorly between the crura, hinged proximally at the level of the verumontanum, tubularised, and relocated posteriorly within the grasp of the external sphincter complex. This necessitates the construction of an interim penoscrotal urethrostomy prior to penile urethroplasty. The physiological continence rating achieved so far in 19 patients is 73%. The identification and localisation of a latent but effective external sphincter muscle complex situated deep in the pelvis and totally separated from the dorsal penile plate in the male and from the urethrovaginal outlet in the female formed the basis and rationale of this new radical soft-tissue mobilisation technique.

Key words Vesical exstrophy · Ectopia vesicae · Epispadias · Vesico-urethroplasty · Urinary continence

Introduction

The purpose of this paper is to describe a new, staged surgical technique for the repair of vesical exstrophy using radical soft-tissue mobilisation of all sphincter musculature and remodelling of the penis to achieve physiological continence and satisfactory genital function. Hitherto, the published rate of continence achieved has averaged only about 50% using methods that concentrate on pelvic girdle osteotomy and bladder neck sphincteroplasty. The results so far using the technique described below indicate that 14 out of 19 patients (73%) have achieved physiological urinary control.

This new technique involves radical mobilisation of the periosteum of the pubis and ischium together with the attachments of all sphincter and levatores ani muscles, the pudendal nerves and vessels, and the corpora cavernosa without any form of pelvic osteotomy but using a muscle stimulator to assist in identification of voluntary muscle. This procedure allows an innervated total sphincter wrap around the new pelvic urethra without tension.

In the male infant, the stages are: (1) shortly after birth, closure of the dome of the bladder and repair of inguinal herniae; (2) reimplantation of the ureters, construction of the prostatic and membranous urethra with associated sphincters, penile elongation, and creation of a penoscrotal urethrostomy at 3 to 6 months; and (3) construction of the penile urethra ("hypospadias" repair) at about 3 years. Reconstruction of the female classic exstrophy anomalies requires only two stages, namely, (1) closure of the dome of the bladder and abdominal wall and formation of a stoma at the bladder neck; and (2) reimplantation of the ureters, urethral construction, and pelvic urethral sphincteroplasty.

Materials and methods

This new procedure has evolved during the past 7 years (1987–1993) in 27 patients, 17 males and 10 females, all of whom had sphincter construction by the technique described. Of these 27, 13 were "re-do"

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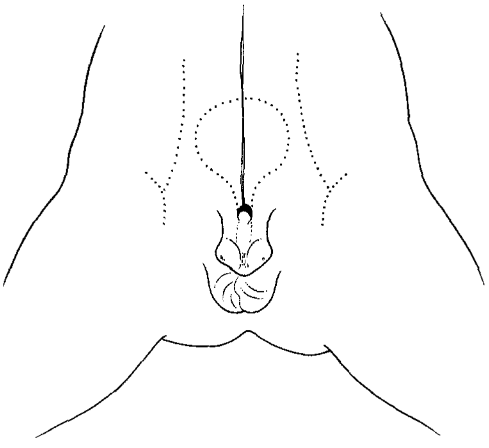


Fig. 1 Classic vesical exstrophy. Dotted lines indicate edges of rectus muscles and inturned bladder and stoma at completion of stage 1; healed midline incision (*solid line*); urethral plate on dorsum of penis extending from stoma to glans

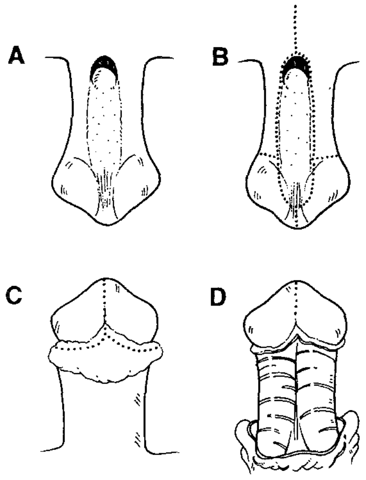


Fig. 2 A–D Epispadiac features at stage 2. **A** Urethral plate (*speckled*) on dorsum; **B, C** demarcation of incisions (*dotted lines*); **D** degloved penis and exposed corpora of short ventral shaft

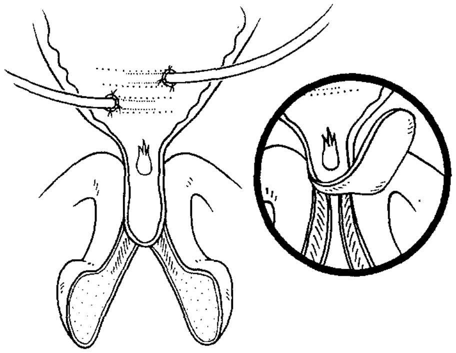


Fig. 3 Reimplantation of ureters; elevation of urethral plate (*inset*); bisection of glans; separation of corpora cavernosa

procedures, the children having had previous failed attempts to provide urine control. Eight of the 27 children have been operated upon too recently for assessment of urinary control or are less than 4 years of age. The remaining 19 range from 4 to 11 years and have been assessed recently for general development, renal integrity, and urinary continence. Excluded from the series were patients with cloacal exstrophy and vesical exstrophy complicated by imperforate anus or sacral agenesis. While it is technically possible to use the same principles of repair for these patients, the results to date have been disappointing. The following description applies to the unoperated newborn, but the principles apply equally to the older or previously operated child.

Vesical exstrophy in the male

Management of newborn males with classic vesical exstrophy involves three separate operations: at birth, at 3 months, and at 3 years. For older patients requiring "re-do" operations, the timing is governed by the state of repair and many other considerations such as social, psychological, and age factors.

Stage 1. Bladder closure at birth

The newborn is operated upon as soon after birth as possible. If surgery is delayed, bladder mucosal ulceration and oedema develop rapidly as the mucosa is exposed to the effects of drying, friction, and bacterial contamination, all of which mitigate against successful inturning of the bladder.

The dome of the bladder is inverted and the abdominal wall deficiency and inguinal herniae are repaired. The superior three-quarters or more of the circumference of the bladder is incised at the junction of skin and mucosa. The umbilicus is excised and, if necessary, the incision carried superiorly in the midline. The medial margin of the rectus muscle defines the plane of dissection to detach the bladder from the abdominal wall and peritoneum. Dissecting the umbilical arteries from the peritoneum facilitates the dissection and separation of the peritoneum from the back of the bladder. The bladder is drawn into an anterior extraperitoneal position behind the rectus muscles and the dome of the bladder is inturned in the midline as far caudally as the future bladder neck, where a small stoma is established. No attempt is made to tubularise the urethra at this stage. Ureteric catheters (No. 3.5 or 5 F) are inserted and anchored to the trigone to ensure free drainage of the upper tracts for several days post-operatively. No suprapubic or urethral catheter is used.

The inguinal canals are explored in the properitoneal plane on each side and ligation and division of the patent processus is performed. The medial margins of the rectus sheaths are approximated in the midline. Although the pubic bones are widely separated, the gap between attachments of the rectus sheaths to the pubic bones in the newborn is usually a small triangle that just accomodates the vesicourethral stoma. Sometimes the anatomical separation of the rectus muscle is too wide for primary approximation even at birth, necessitating construction of hinged flaps cut from the rectus sheaths to bridge the gap. This is more commonly required in the second stage.

Throughout the entire series of operations all sutures used are absorbable (braided polyglycolic). Heavy sutures (2/0) are appropriate for approximation of the layers of the abdominal wall (and the muscle wrap around the new urethra in stage 2); elsewhere finer (4/0 and 5/0) are suitable. Intra- and post-operative antibiotics are routinely given for all stages.

Stage 2

Reimplantation of the ureters and construction of a posterior pelvic urethra and reconstruction of the penis are performed at 3 to 6 months. Vesico-ureteral reflux of urine and urinary infection (UTI) are so common after bladder reconstruction that prophylactic anti-reflux surgery at this stage is recommended.

The outline of the urethral plate on the dorsum of the penis from the stoma to the glans is marked and incised. The incision is continued around the corona and the shaft is degloved, exposing the distal parts of the corpora cavernosa, the bodies of which are then separated from one another by deep dissection, and on the dorsal aspect the urethral plate is elevated from the penile shaft (Figs. 1, 2). The glans penis is very thin in the midline and is easily divided, separating the penis into two halves. The lower midline abdominal skin scar is incised and deepened to lay open the lower abdominal wall and bladder. At this stage anti-reflux surgery is performed, the ureteric orifices being transplanted either cranially or transversely (Fig. 3).

Attention is now turned to the mobilisation of all soft-tissue structures attached to the medial walls of the pelvis. The periosteum of the medial surface of the anterior pelvic bones is freed with the diathermy needle, beginning on the anterior surface of the pubic bone and continuing onto the ischio-pubic ramus and ischium (Fig. 4). Crossing from anterior to posterior at the level of entry of the obturator nerve and vessels into the pelvis is the attachment of the levatores ani to the pubis, the fascia overlying the obturator internus muscle, and the ischial spine. The levator ani is detached from the fascia along the

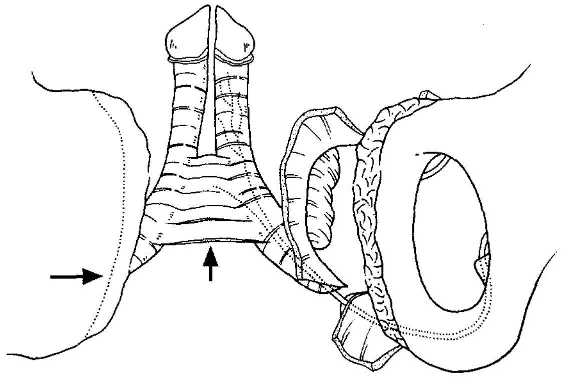


Fig. 4 Periosteal mobilisation. Incision in periosteum indicated by dotted line (*long arrow*) and raw area by speckled surface of pubis and ischium; freed periosteum with muscles attached floats medially; pudendal nerve and vessels liberated from Alcock's canal (*double dotted line*); bulbo-cavernosus muscle (*short arrow*)

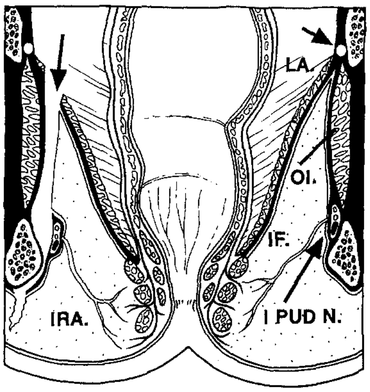
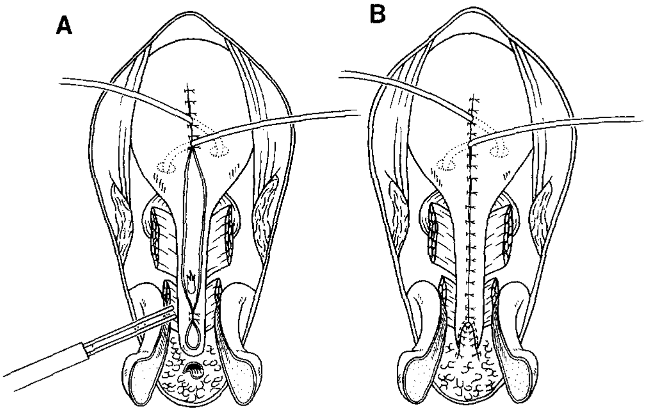


Fig. 5 Coronal section through normal pelvis to show attachment of iliococcygeus muscle to obturator fascia at white line (*short arrow*) and mobilisation of vessels and nerves in Alcock's canal from fascia (*IRA* inferior rectal artery, *LA* levator ani muscle attaching to white line, *OI* obturator internus muscle, *IF* ischio-rectal fossa, *IPUDN* internal pudendal nerve and vessels) [8]

white line, a linear thickening of the obturator internus fascia. This manoeuvre brings into view the fat of the ischio-rectal fossa and exposes the deep part of the obturator fascia and the pudendal vessels and nerve in Alcock's canal (Fig. 5). The periosteum is then peeled from the ischio-pubic ramus and ischium, liberating the pudendal vessels and nerves more anteriorly and mobilising the attachment of the crura from the ischio-pubic ramus (Fig. 4). This procedure is repeated on the opposite side. Thus, on each side all the lateral origins of the potential urethral sphincter muscles as well as the levatores ani muscles, pudendal nerves and vessels, and crura of the corpora cavernosa are liberated from the widely separated pelvic bones. These muscles and crura are then free to be approximated in the midline without tension and without undue stretching of the pudendal nerves and vessels.

In the vesical exstrophy anomaly the transversus perineii, sphincter urethrae, and bulbo-cavernosus and ischio-cavernosus muscles lie as a continuous muscle mass stretched between and attached to the crura (Fig. 4) that is in continuity with the external anal sphincter and can be identified by its contractile response to the muscle stimulator. Its attachments at the posterior end of the corpora are now dissected from the crura to permit them to be wrapped with the external urethral sphincter muscles around the "new" urethra.

Fig. 6A, B Construction of pelvic urethra. **A** View of tubularised urethral plate redirected deep in pelvis posterior to crura; U-shaped skin flap inturned to meet plate. Note muscle stimulator positioned on intercrural muscle bundles continuous with external sphincter complex. **B** Plate edges approximated with fine absorbable, sutures in continuity with those of bladder wall; note intercrural muscle bundles not yet freed from posterior ends of crura; U-shaped skin flap integrated into anterior quadrant of plate – stoma concealed behind flap



The "new" posterior urethra is formed by tubularisation of the urethral plate and then redirected between the posterior limits of the crura to the penoscrotal site of the temporary urethrostomy (Fig. 6). In constructing this stoma, penile skin is inturned as a U-shaped flap and integrated into the anterior quadrant of the new urethra. This skin flap is based on the ventral aspect of the penis near the midshaft, and the free edge is at the penoscrotal junction, which ensures a long, oblique urethro-cutaneous anastomosis. The margins of the bladder are closed in continuity with the new tubularised urethra (Fig. 6). The freely mobilised internal and external sphincter muscles, together with the origins of the levator ani muscle, are now wrapped around the new urethra. About ten separate sutures are placed in the sphincter muscles, taking bites of the attached cut edges of mobilised periosteum to hold the union. All sutures are placed before any are tied (Fig. 7). As the sutures are tied the new urethra becomes angulated posteriorly and caudally, mimicking the natural angulation between membranous and bulbar urethra.

The fibrous sheaths of the crura and shaft are now sutured together in the midline (Fig. 8). The positioning of the sutures is critical: if the line of sutures is too much on the dorsal side, dorsal chordee will be recreated; if too ventral, ventral chordee will result. The alignment is judged by trial and error, and appropriate placement of sutures will correct the inherent dorsal chordee. One row of sutures is required to maintain the correction; more than one row may result in ischaemic necrosis. Penile elongation and external projection of the shaft of 2–3 cm in a 3-month-old baby is usually achieved by this midline approximation of the crural bodies (Fig. 8). The epithelium covering the cleft on the dorsum of the glans is trimmed and two layers of fine absorbable sutures are inserted to restore the normal shape of the glans (Fig. 9).

It now remains to close the distal triangular deficiency in the abdominal wall between the divaricated pubes. Negative-pressure drainage tubes are inserted into the lateral pelvic dead spaces. The medial edges of the rectus sheaths are then approximated in the midline except caudally between the pubes. The gap is covered by flaps cut from the rectus sheaths that are hinged distally, turned caudally, and anchored to the inner side of the pubes, inferior pubic rami, and the sides of the shaft of the penis (Fig. 10). This is followed by subcutaneous and cutaneous closure.

Postoperatively, the dead spaces are drained until fluid no longer accumulates; the ureters are intubated with catheters to divert the urine for 7 days post-operatively. The urethra is intubated with a 5 F feeding tube during the tubularisation of the urethral plate, but this tube is removed at the end of the operation as an indwelling urethral catheter in addition to the squeeze of the sphincter wrap may cause mucosal

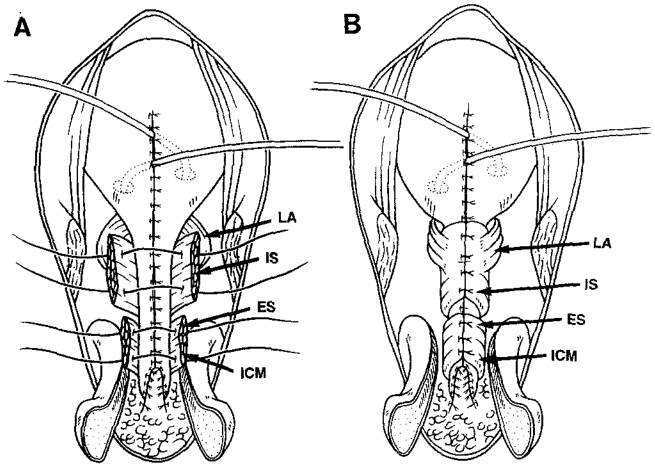


Fig. 7A, B Construction of urethral sphincter wrap. **A** Intercrural muscle bundles freed from posterior ends of crura become continuous with voluntary muscle of external sphincter; four of ten heavy absorbable sutures shown inserted through lamella of periosteum and sphincter complex and left long until all have been placed. **B** Sphincter muscles including intercrural fibres wrapped around tubularised urethra (*LA* levator ani muscle, *IS* and *ES* internal and external sphincter complex, *ICM* intercrural msucle)

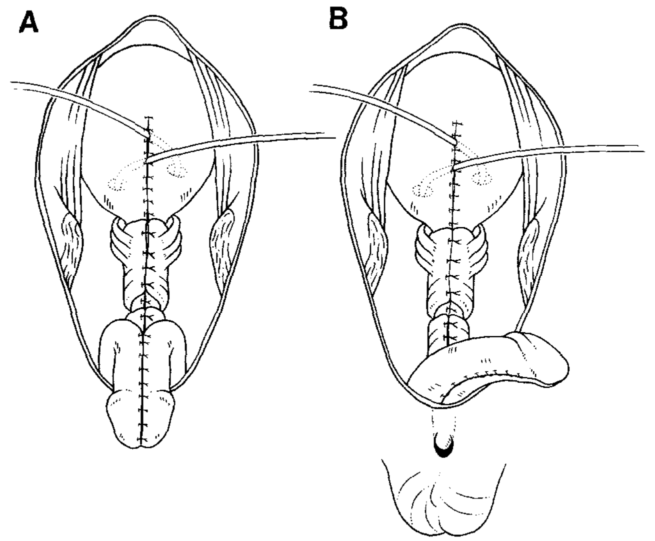


Fig. 8A, B Apposition of corporal bodies and halves of glans. **A** Corpora cavernosa of crura and shaft sutured together in midline with dorsal row of fine absorbable sutures. **B** Ventral row of sutures in sheaths of corpora cavernosa and skin of glans. Note position of urethral stoma on penis anterior to scrotum

necrosis and subsequent stricture formation. An O monofilament nylon thread may be left in the urethra, passing out through the bladder dome and abdominal wall and tied as a loop, to facilitate urethral instrumentation in the post-operative phase should this be necessary. Suprapubic catheter drainage may be suited to some patients with large bladders, but should be avoided in patients with small, thick-walled bladders.

Intra- and post-operative epidural anaesthesia for up to 3 days has employed in most of the children having the stage 2 procedure. Not only does this provide excellent operative conditions and post-operative analgesia, but the children also remain relatively immobile, facilitating rapid healing.

Stage 3. "Hypospadias" repair

At approximately 3 years of age, when continence is achieved, the urethral lumen has been checked as adequate, and any other complications corrected, e. g., urethral meatal stenosis or urethral diverticulum, the penile urethra is constructed. The technique is described and illustrated in Figs. 12–14. The lining of the urethra is obtained from inturned skin of the shaft and glans. Immediate covering of the raw area can be effected by coaption of penile skin if sufficiently redundant. In some children, however, owing to a lack of sufficient penile skin, a lateral vascularised perineal skin flap based on the penoscrotal stoma may be shifted on its vascular pedicle over the raw area, sewn to the skin of the shaft, and integrated into the base of the glans.

Vesical exstrophy in the female

Stage 1 is similar in principle to that already described in males; stage 2 is also similar except in the followig respects.

The urethra is tubularised from the urethral mucosa as far caudally as the opened-out external meatus and margin of the vaginal orifice. The whole thickness of the lateral margins of the urethral mucosa together with a sliver of adjacent skin measuring in total about 1.2 cm is cut to tubularise the urethra in situ. The sphincter and levatores ani and periosteum detached from the pelvic bones are wrapped around both the new urethra and vagina. No attempt is made to construct a wrap around the urethra only, because the adherent coats of the urethra and vagina cannot be separated without damage to one or both. The meatus of the urethra and introitus of the vagina are transposed posteriorly. A Y-V plasty incision is made behind the vaginal orifice extending posteriorly in the midline for at least 1.5 cm. This transposition allows the urethra and vagina to fall back within the grasp of the short muscle bundles of the wrap. The lateral pelvic periosteal mobilisation of the crura of the two halves of the clitoris facilitates the midline apposition of the glans clitoris.

Other forms of exstrophy

Babies born with the anomaly known as the pubovesical cleft may be spared stage 1 because the dome of the bladder is well developed and the natural stoma is pubic. Surgery of stage 2 is as described. For penile epispadias with incontinence the remodelling procedure with or without local periosteal mobilisation of the crura may be appropriate.

Results

The results of sphincter surgery in the 27 patients was assessed by direct questioning of the child and family and physical examination, with some children also undergoing micturating cysto-urethrograms. The results of recent operations in 8 patients are too early to assess; the remaining 19 were assessed at least 1–2 years after stage 2 operation. These children have been divided into three groups based on continence ratings.

Group 1 comprises 7 children who have normal neuromuscular urinary control both day and night with complete or near-complete bladder emptying. Group 2 includes 7 patients who are socially continent, i. e., the child has neuromuscular control with day dryness but may need to undertake a frequent voiding routine to avoid wetting. These patients may have occasional accidental voiding by day or night or may wear a pad "just in case", but their urinary control mechanism is intact and their potential for improvement with age and maturation is possible. Group 3 includes 5 patients who are incontinent, i. e., wet day and night, 1 of whom has been converted to a continent

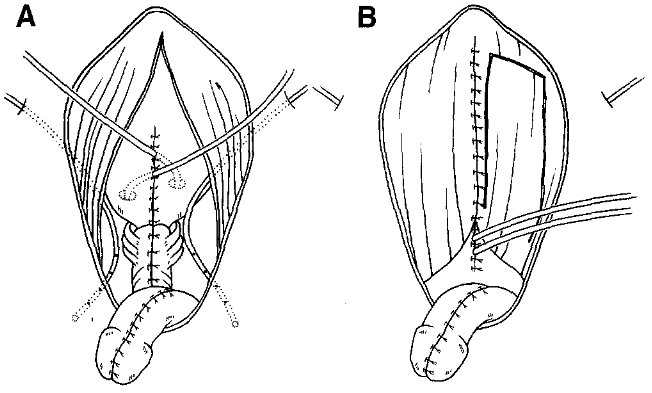


Fig. 9 A, B Abdominal wall repair. **A** Negative pressure suction drain tubes inserted through abdominal wall into dead spaces. **B** Rectus sheaths approximated except for inter-pubic gap; left rectus sheath flap mapped and cut

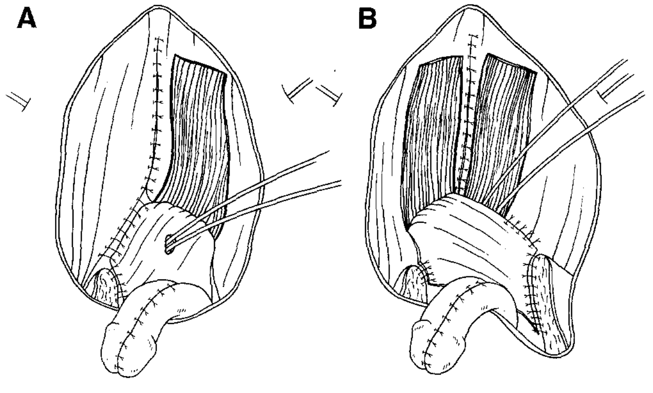


Fig. 10 A, B Abdominal wall repair. **A** Left rectus flap turned down and sutured to opposite rectus sheath, pubis, inferior ramus, and side of sheath of right corpus cavernosum. Ureteric catheters led through button-hole in flap. **B** Right rectus sheath flap turned across to opposite pubis, ramus, and sheath of left corpus cavernosum

diversion and a further child awaiting a similar operation. (Table 1).

Four males and 3 females are fully continent (group 1), 5 males and 2 females are socially continent (group 2), and 4 males and 1 female are incontinent. Of the 8 patients who have had primary stage 2 operations too recently to be assessed, there are 4 males and 4 females. The 14 patients in groups 1 and 2 include 9 who have had revision stage 2 sphincteroplasty by the author, 7 males and 2 females. Of the 7 males, 4 have achieved physiological and 3 social continence. Both of the female children are now socially

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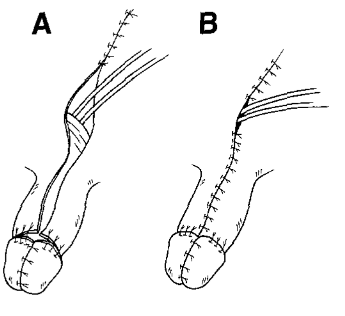

Fig. 11 A, B Penile skin closure. **A** Skin of penis rolled back into place, trimmed around corona, and **B** approximated with fine interrupted absorbable sutures

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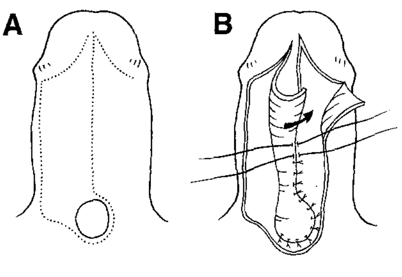

Fig. 12 A, B Stage 3 hypospadias repair. **A** Tubularisation of penile urethra; incision indicated by dotted line beginning on glans, curving laterally on corona and proximally along right lateral border of shaft, then medial deviation around stoma and distally in midline to left side of glans beside point of origin; from there incision curves laterally on corona. **B** Longitudinal skin flap medially hinged and elevated on right side of shaft and turned medially to form roof of urethra; on left side, skin is undercut to make a longitudinal laterally hinged flap; interrupted fine sutures between cut edges of skin tube

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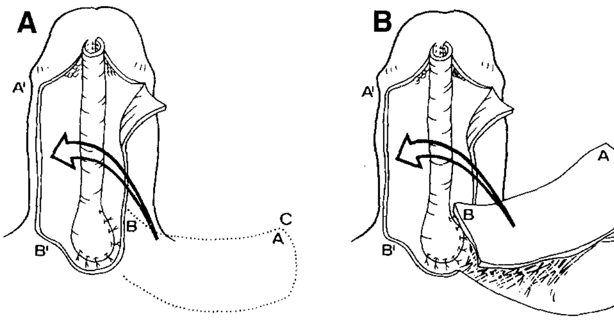

Fig. 13 A, B Skin transfer. **A** Laterally directed skin flap outlined on left side. Corner B will slide over to B1 and corner A will slide across to A1; *arrow* indicates direction of slide. **B** Vascularised, medially hinged pedicle flap ready for transfer onto raw area (*arrow*)

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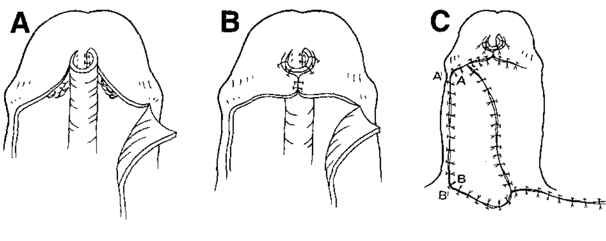

Fig. 14 A–C Meatoplasty and shift of skin flap. **A** Urethra tubularised with penile skin to meatus; glans skin undercut and mobilised laterally from meatus. **B** Glans skin elevated and sutured to meatus and to itself across midline, mimicking a frenulum. **C** Pedicled skin graft covering raw shaft area in place; skin edges around graft bed sewn together, completing entire skin cover of new penile urethra

Table 1 Current continence ratings after soft-tissue repair of vesical exstrophy

State of control	Males	Females	Total
Assessed for urinary control	13	6	19
Physiological continence	4	3	7
Social continence	5	2	7
Incontinence	4	1	5
Too early to assess	4	4	8
Total	17	10	27

continent. Of the 5 patients in group 3, 2 had primary second-stage operations in which the intercrural muscles were not used to maximum advantage early in the period of evolution of the technique. The mobilisation of the muscles was limited and further sphincteroplasty surgery may improve continence. Two male patients had had multiple previous attempts at surgical repair without success before entering this series. In the incontinent female patient an attempt was made to separate urethra from vagina, which led to urethral stricturing. Furthermore, the operation of sphincter mobilisation in that child was not as complete as in the present technique.

Seven patients have had penile urethral construction (stage 3) completed. Of these, 2 have developed a fistula that needs repair; the others void satisfactorily. The appearance of the penis varies from child to child, but it will be some years before the sexual adequacy can be assessed.

Complications during the post-operative management of the 27 patients were infective and mechanical. Sixteen patients had recurrent UTIs in the early years after operation. The mechanical complications included 2 urethral strictures, 5 major or minor wound dehiscences, 2 in stage 1 and 3 in stage 2, and 2 cases of infective bladder calculi that have since been removed.

Discussion

Since 1906, when Trendelenburg [10] reported surgical reconstruction of vesical exstrophy aided by disarticulation of the sacro-iliac joints, pelvic osteotomy in one form or another has become common practice. At the time of or shortly after osteotomy, the bladder and abdominal wall are repaired. The prostatic urethra and urethral plate are tubularised with or without interposition of a segment made from paravesical skin flaps [3–6]. The focus in the construction of sphincteric control is directed to the muscle wrap around the prostatic urethra and bladder neck. This column of involuntary muscle may be elongated in continuity by a Young tubularisation of the trigone of the bladder [9]. This procedure accords with the Lapides principle governing the length of urethra (3–4 cm in the adult) that is required to achieve continence. Ansell [1, 2] took a slice of the medial aspect of each pubis with its attached soft tissues, mobilised the periosteum of the ischiopubic ramus, and was able to construct a sphincter wrap and coapt the pubic fragments. By this technique, used in 12 neonates, good results were achieved in 3, stress incontinence resulted in 2, and 7 remained incontinent.

In the technique described here, the mobilisation of the periosteum together with pelvic and perineal structures is much more extensive than in any previous descriptions and the focus of sphincter reconstruction is on both the prostatic urethra and the striated external sphincter complex of a new "membranous" urethra. The technique has evolved over the period under discussion and details of the operative technique have changed to some extent.

Mobilisation of the crura, separation of the corpora cavernosa, and splitting of the glans have a threefold advantage. Firstly, the exposure and identification of the soft-tissue structures deep in the pelvis is greatly enhanced when the corporal bodies are widely separated; secondly, the correction of chordee and remodelling of the penis is facilitated; and thirdly, the shaft of the penis is elongated by coapting the previously separated crura [11]. In addition, it has been found advantageous to formally open the ischiorectal fossa from above.

The enhanced exposure has improved the accuracy and safety of the surgery, but there is still a significant technical challenge associated with such a procedure, and the potential for surgical mishap is considerable. Ischaemic necrosis of the corporal bodies or glans penis has not occurred in any of the 15 male patients. Thorough knowledge of the detailed anatomy of the pelvis in the normal child and the child with an exstrophic bladder is a pre-requisite before embarking on such surgery.

The quality of life achieved following surgery for bladder exstrophy depends on many aspects: the sex of the child, the development of the pelvic viscera at birth (e. g., bladder size, urethral sphincter development, neurological integrity, phallic size, the presence of associated anomalies), the child's intellectual and emotional development, and the social circumstances are all part of the overall picture, of which the surgical repair is only one factor.

The measure of success varies throughout life. Initially, it relates to survival, reasonable health, a cosmetically acceptable closure, and a minimum of disturbance to the child through the early years. By the time the child reaches school age urinary continence becomes of major importance, as does the need for peer acceptance. With puberty and adulthood comes the need for appropriate sexual appearance and function and the desire for progeny. With increasing age progressive renal deterioration and the threat of malignancy in the repaired or augmented bladder or a diverted system becomes increasingly likely. It can thus be seen that long-term follow-up is essential, and the long-term results of surgery can only be guessed at in the short term. Nevertheless, assessment of bladder control has become the yardstick of success.

Poor results in the development of urinary continence may relate to the size of the bladder at birth. In some patients the initial bladder size is reasonably large and in others it is very small. The experience of the present series has been that even the very small inturned bladder may enlarge if effective sphincter resistance develops after surgery. While the bladder capacity may become adequate in some patients, in others augmentation may be needed to increase bladder volume or a continent diversion may be a preferred alternative.

The knowledge gained through the operative dissection of the patients studied has related particularly to the presence and position of muscle available to be used as a voluntary sphincter. The voluntary sphincter muscle mass is situated between the widely splayed crura of the penis or clitoris and is attached to them and to the ischiopubic ramus, and as such is well posterior to the shaft of the penis and urethral plate in the male. At the level of the prostate the attachments of the muscle mass diverge posteriorly, whereas the urethral plate is directed forward on the dorsum of the penis. The large gap between urethra and sphincters can be bridged by relocating the tubularised urethral plate from the dorsum of the penis backwards between the the two halves of the penis to lie within the grasp of the voluntary sphincter mass once the latter has been detached with the crura from the pelvic wall.

Pelvic osteotomy has been a major part of most reported techniques of repair, but is not part of the operation reported here. We have found that the ambulation of patients with uncorrected pelvic diastasis in childhood is not impaired, but there is some restriction of internal rotation of the hips with consequent inability of some patients to sit with knees crossed. The waddling gait obvious in early childhood resolves spontaneously. The physiological and anatomical repair of bladder exstrophy remains one of the most difficult challenges in paediatric surgery, but in a majority of patients operated using the described technique the early results were most encouraging and compared favourably with other reported series.

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